

Multi-Pathway Uptake of PAHs and n-alkanes from Soil into Aboveground Vegetation

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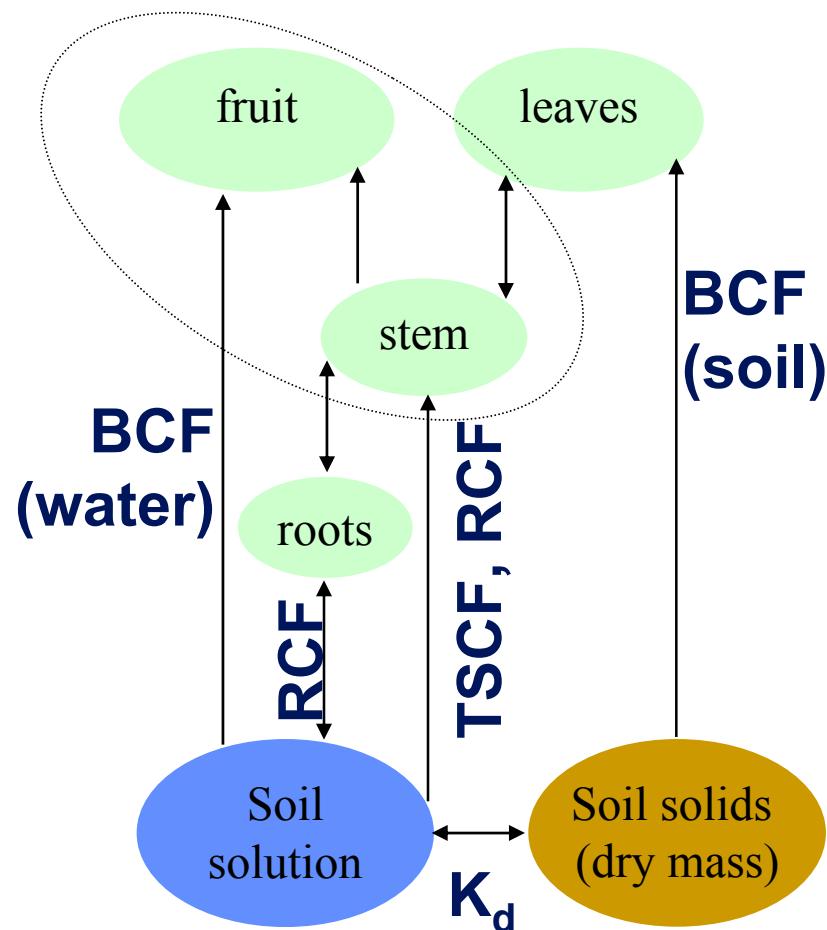
Motivation

- Risk based decisions at contaminated sites
- Uncertainties about accumulation in foodchain:
 - > highly conservative screening models
 - > exceedingly low risk-based soil cleanup levels
- Existing data constrains theory & models
 - > distinction among plants, chemicals and soils
 - > accounting for key transfer & loss mechanisms

Overview

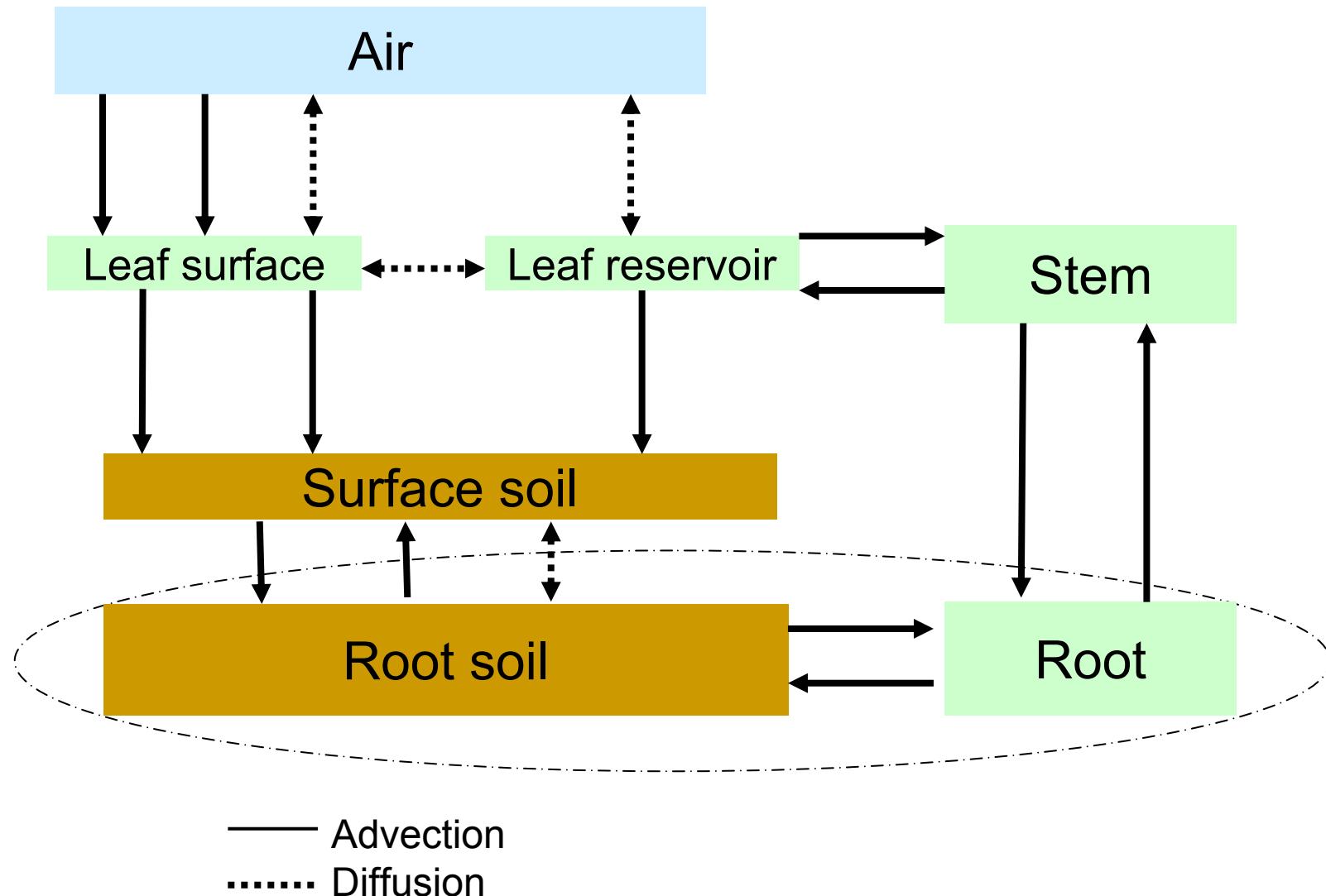
- **Existing soil-plant uptake models**
 - > Relevance to petroleum hydrocarbons
- **Existing soil-plant uptake data**
 - > Relevance to petroleum hydrocarbons
 - > Relevance to contaminated sites
- **Current work measuring soil-to-plant uptake of petroleum hydrocarbons**
 - > Initial findings
 - > R&D challenges

Bioconcentration Ratio Models

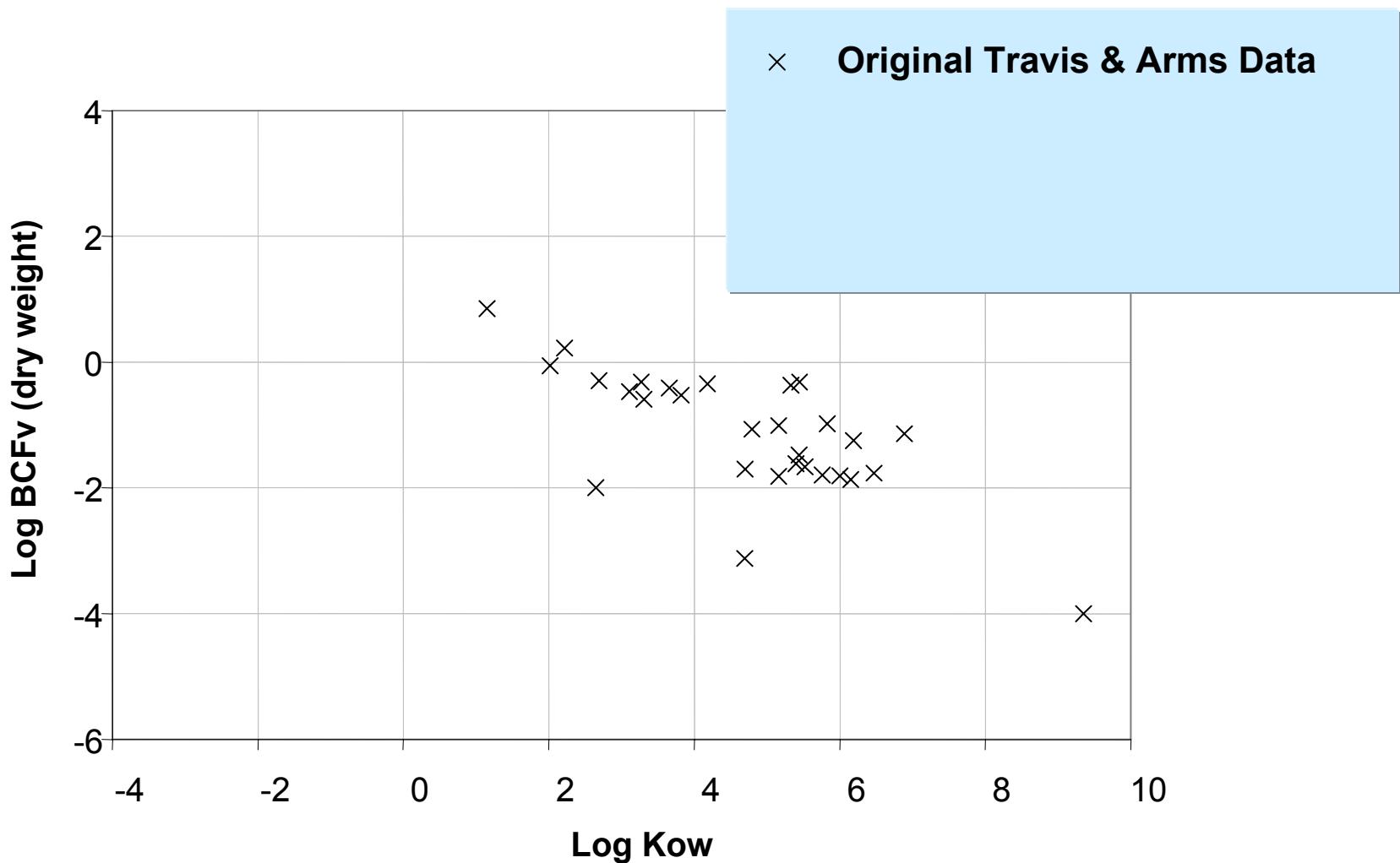


- BCF: Bioconcentration factor
- SCF: Stem concentration factor
- RCF: Root concentration factor
- TSCF: Transpiration stream concentration factor
- K_d : Soil/water partition coefficient

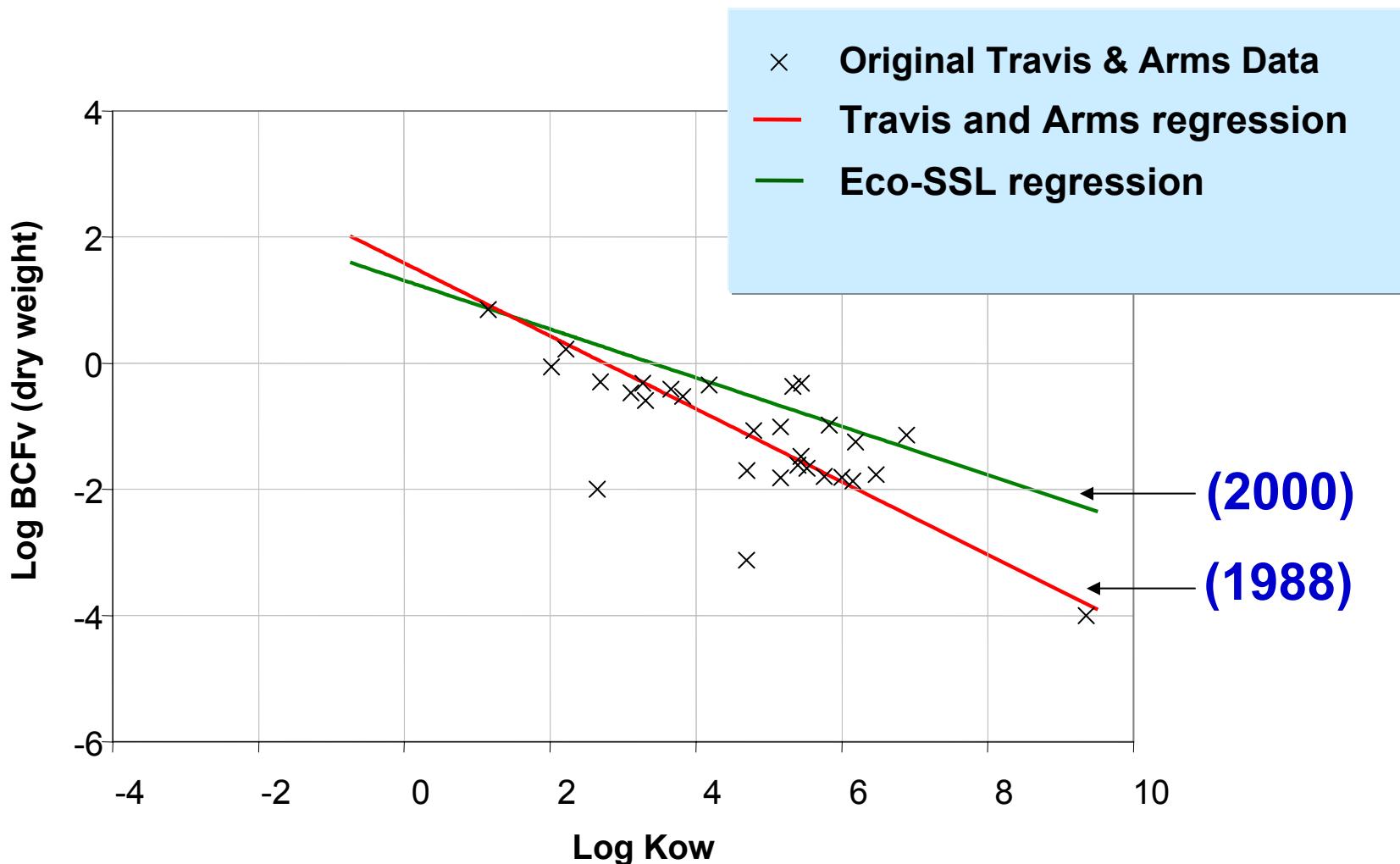
Mass Balance Model



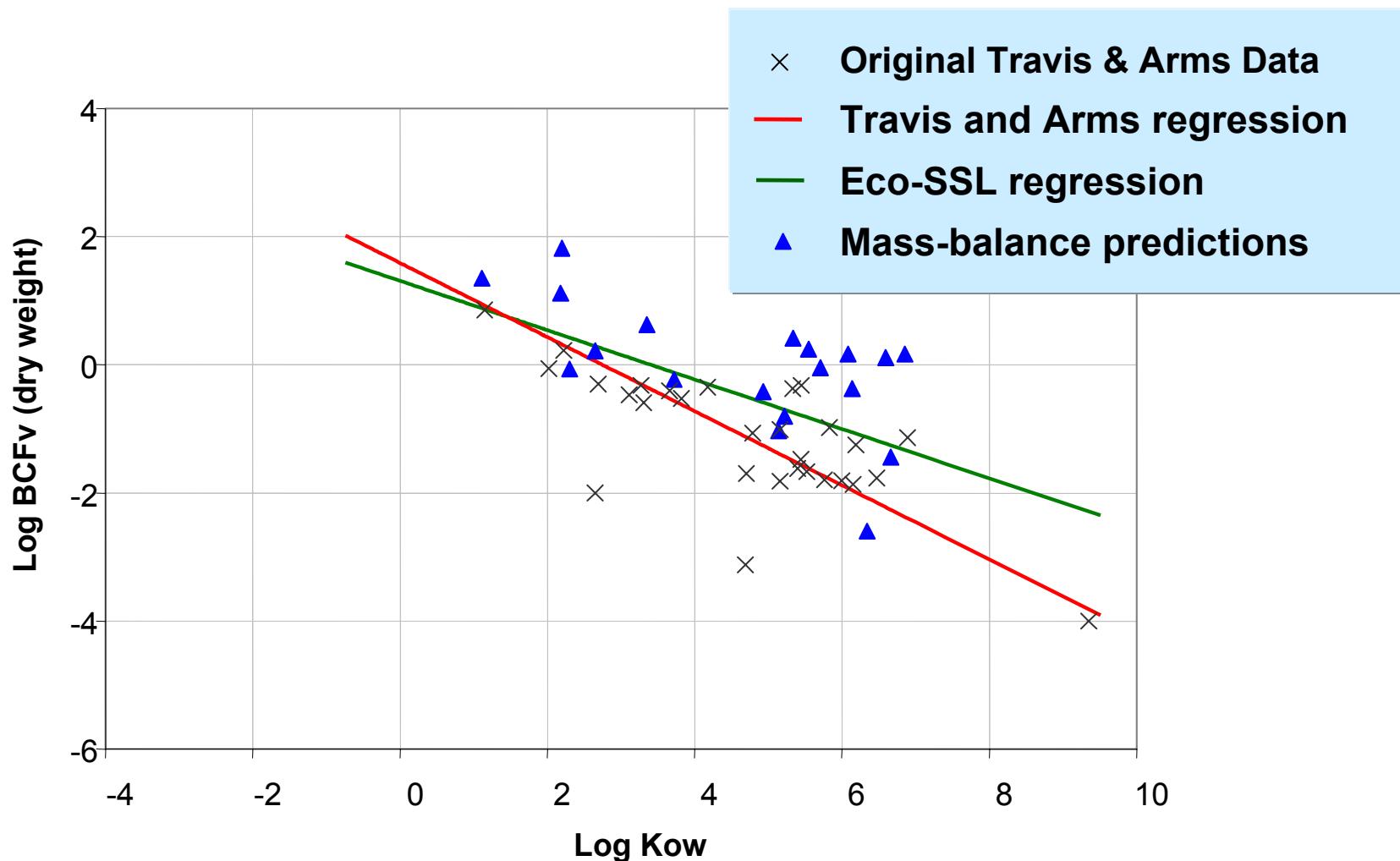
Original measurements of plant uptake



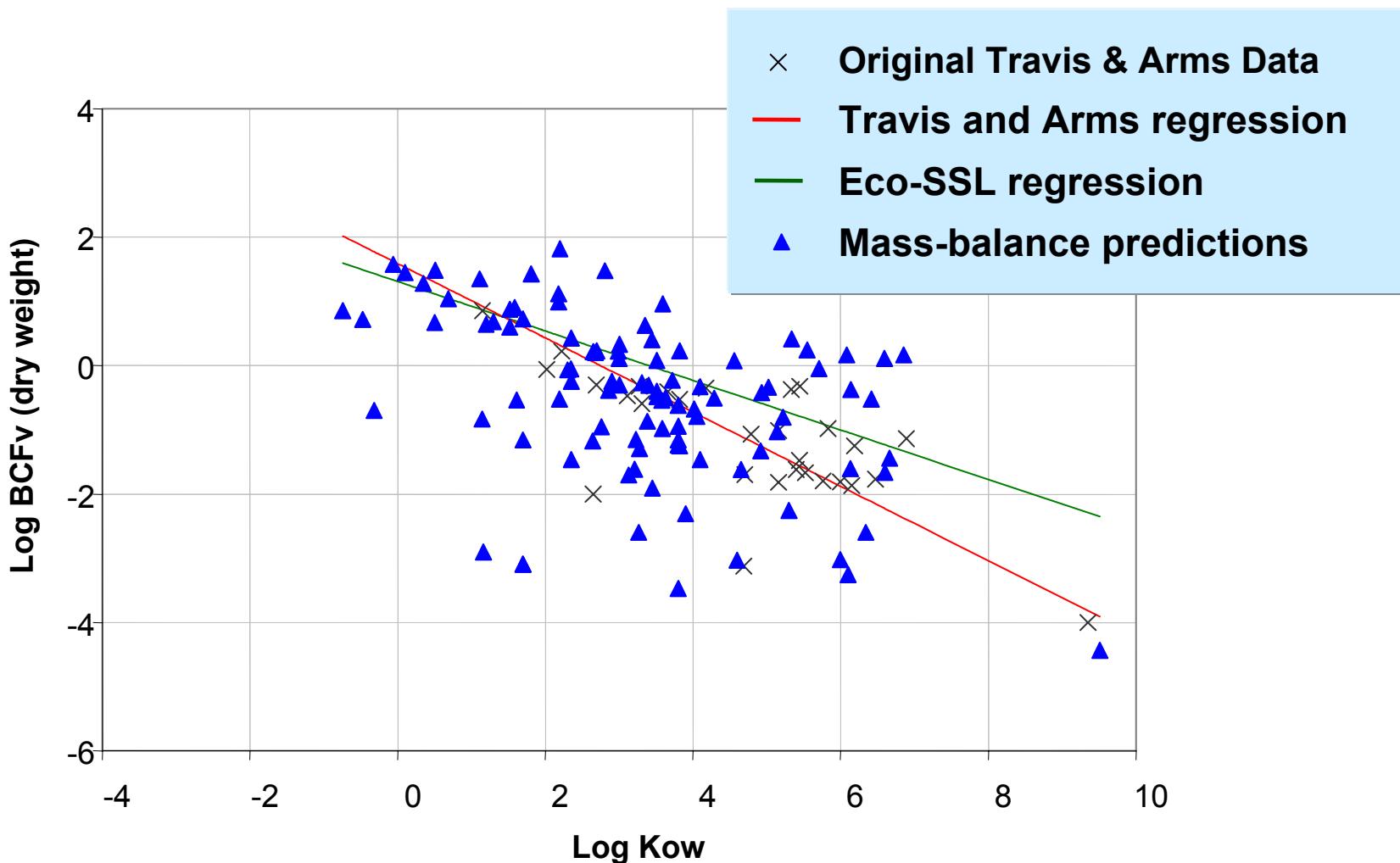
Regression models based on original data



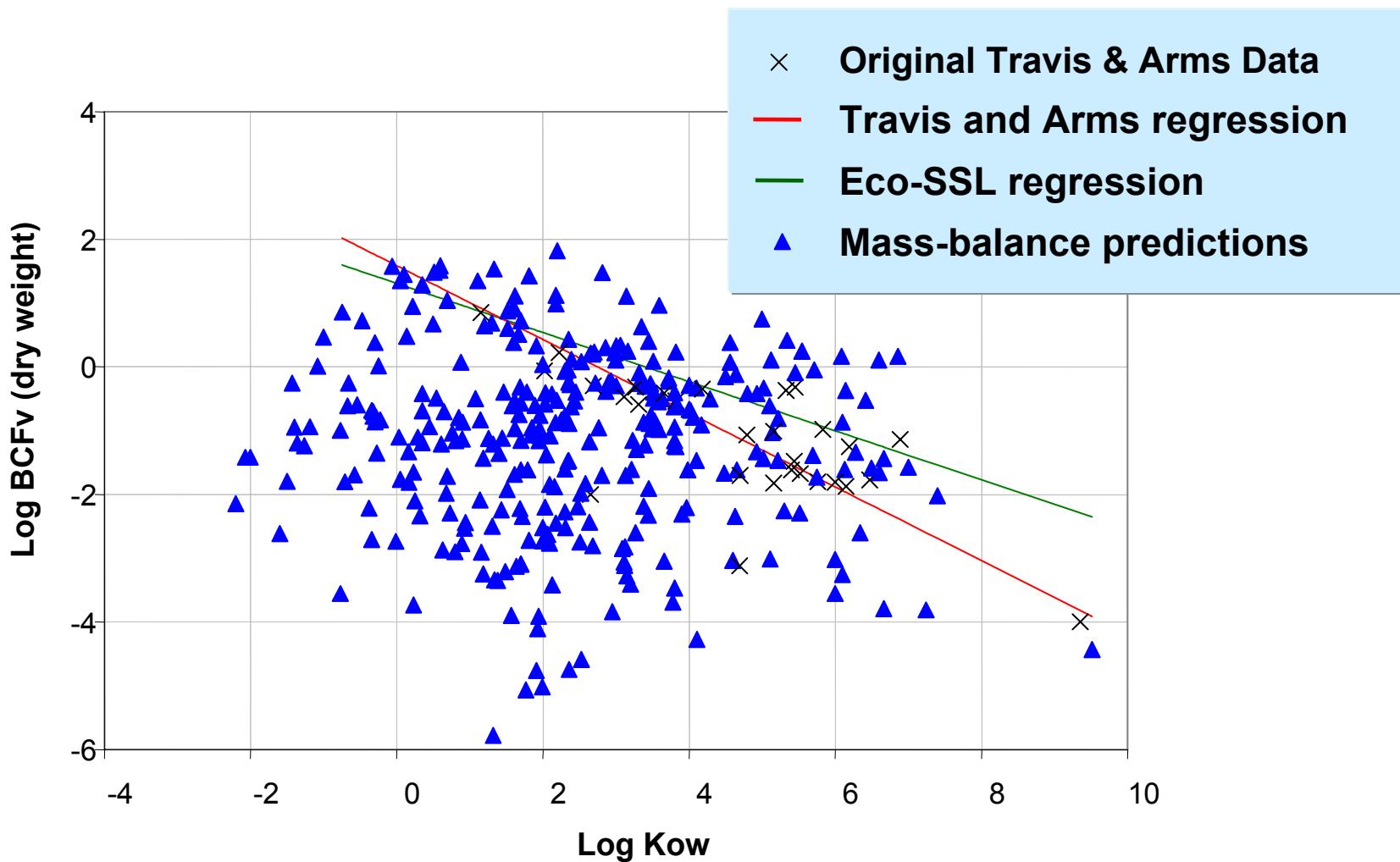
Mass balance predictions for “original data”



Mass balance predictions for extended set of pesticides and chlorinated hydrocarbons

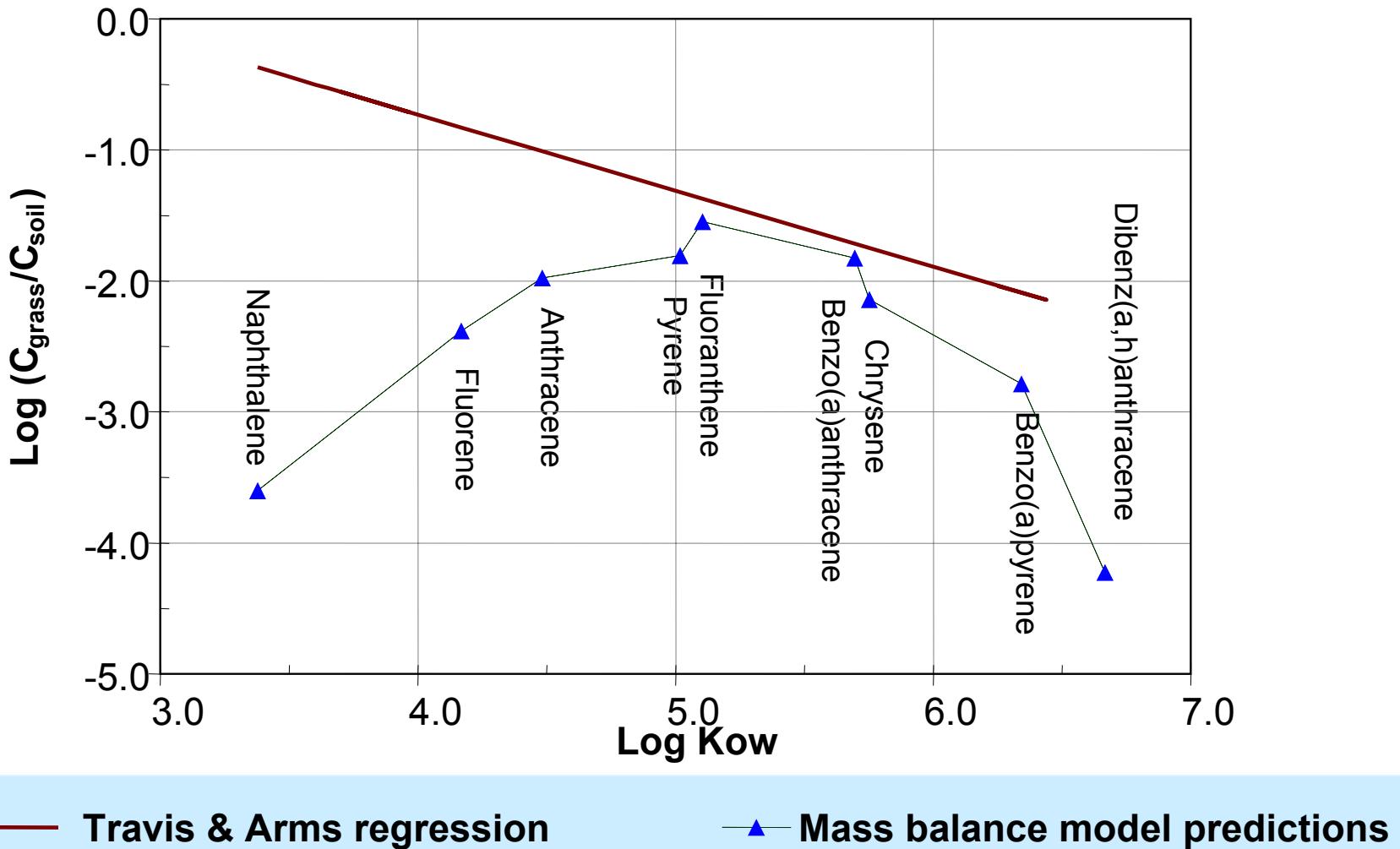


Mass balance predictions for full set of chemicals including petroleum hydrocarbons



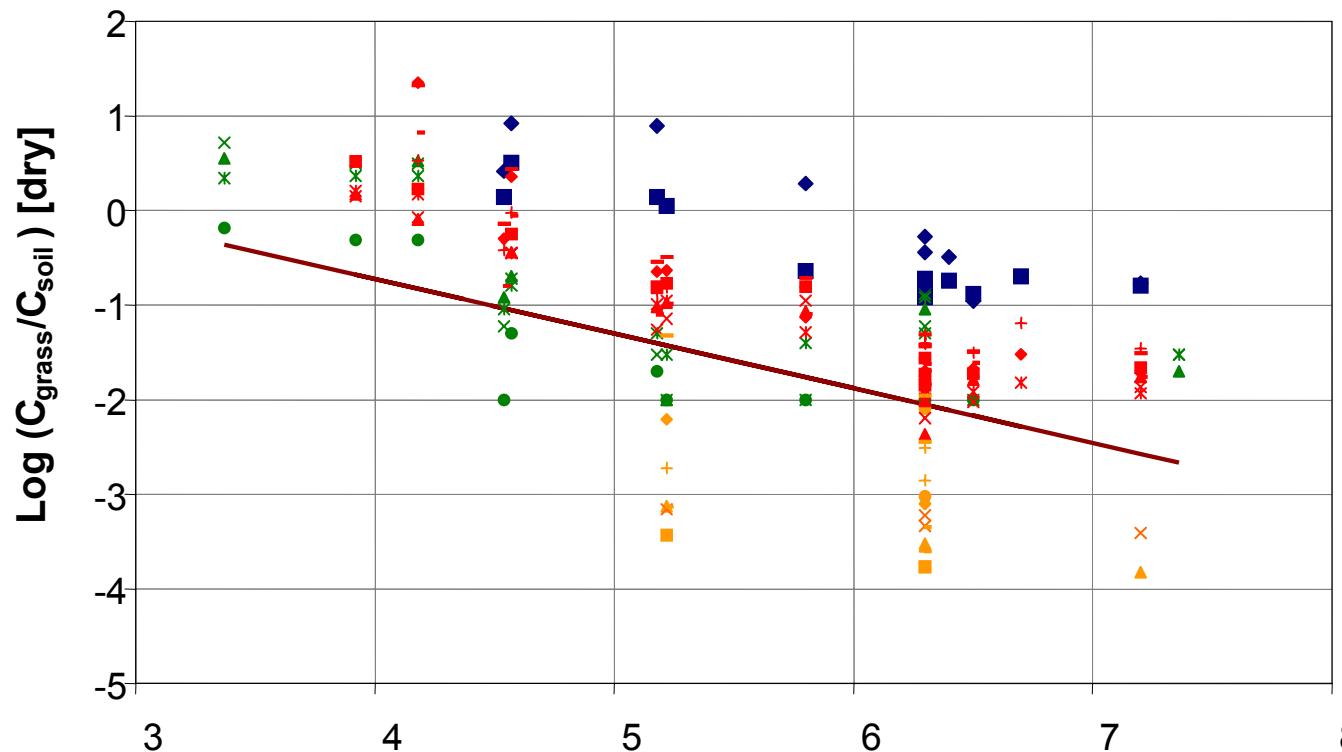
Comparison of plant uptake model predictions for series of PAH congeners

Estimated Bioconcentration Ratios for Aboveground Vegetation



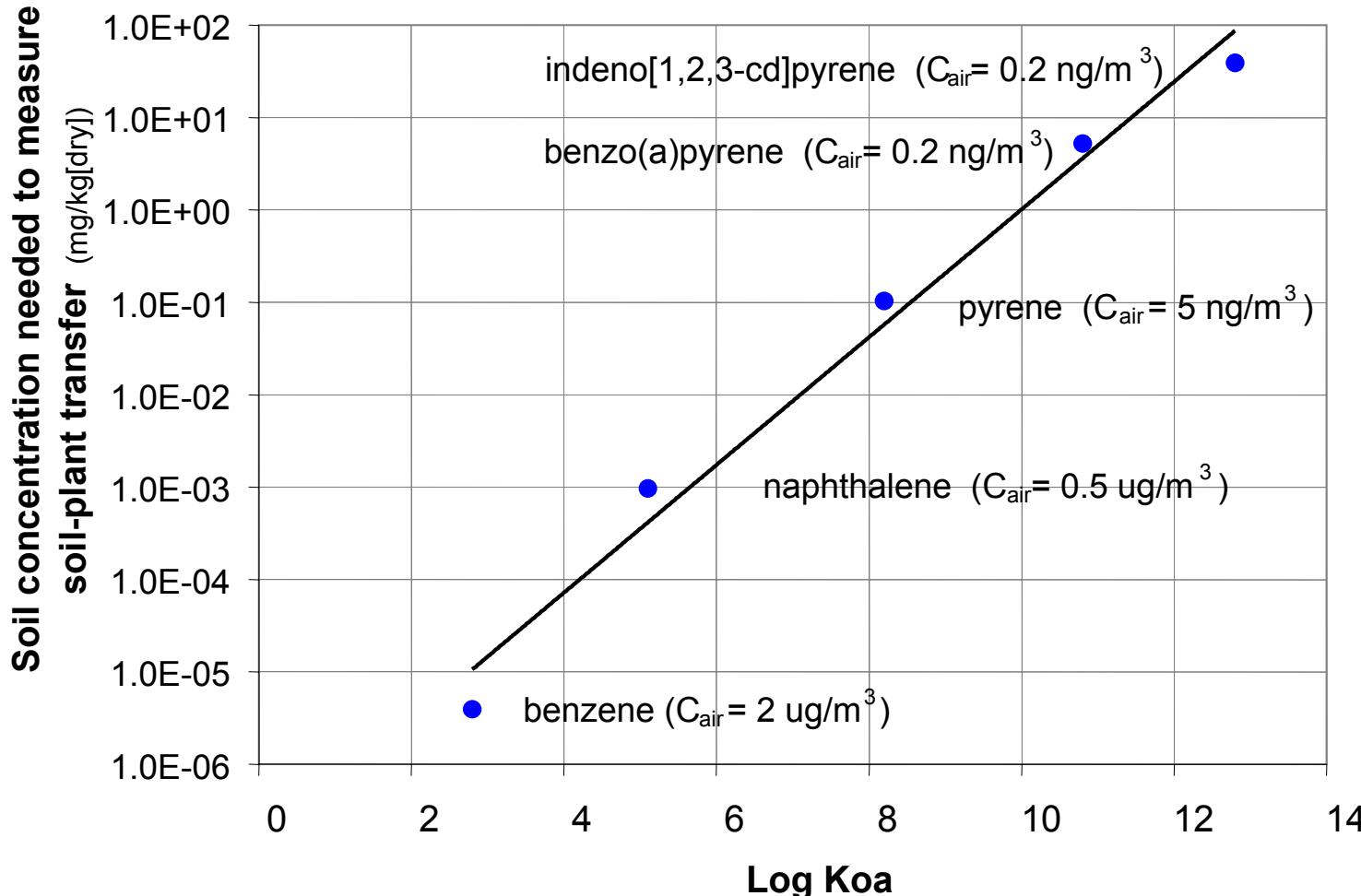
Relevance of plant uptake measurements to contaminated sites

Measured Bioconcentration Ratios for Vegetation



- Log Kow**
- carrot core1 ▲ carrot core2 × carrot core3 * - × carrot core7 ♦ leaf1 ○ leaf2 + leaf3 - leaf4 ■ kale1
 - ▲ kale2 × kale3 * kale4 - squash1 ○ squash2 ■ squash3
 - + parsley1 - parsley2 - parsley3 ♦ parsley4 — Travis & Arms regression

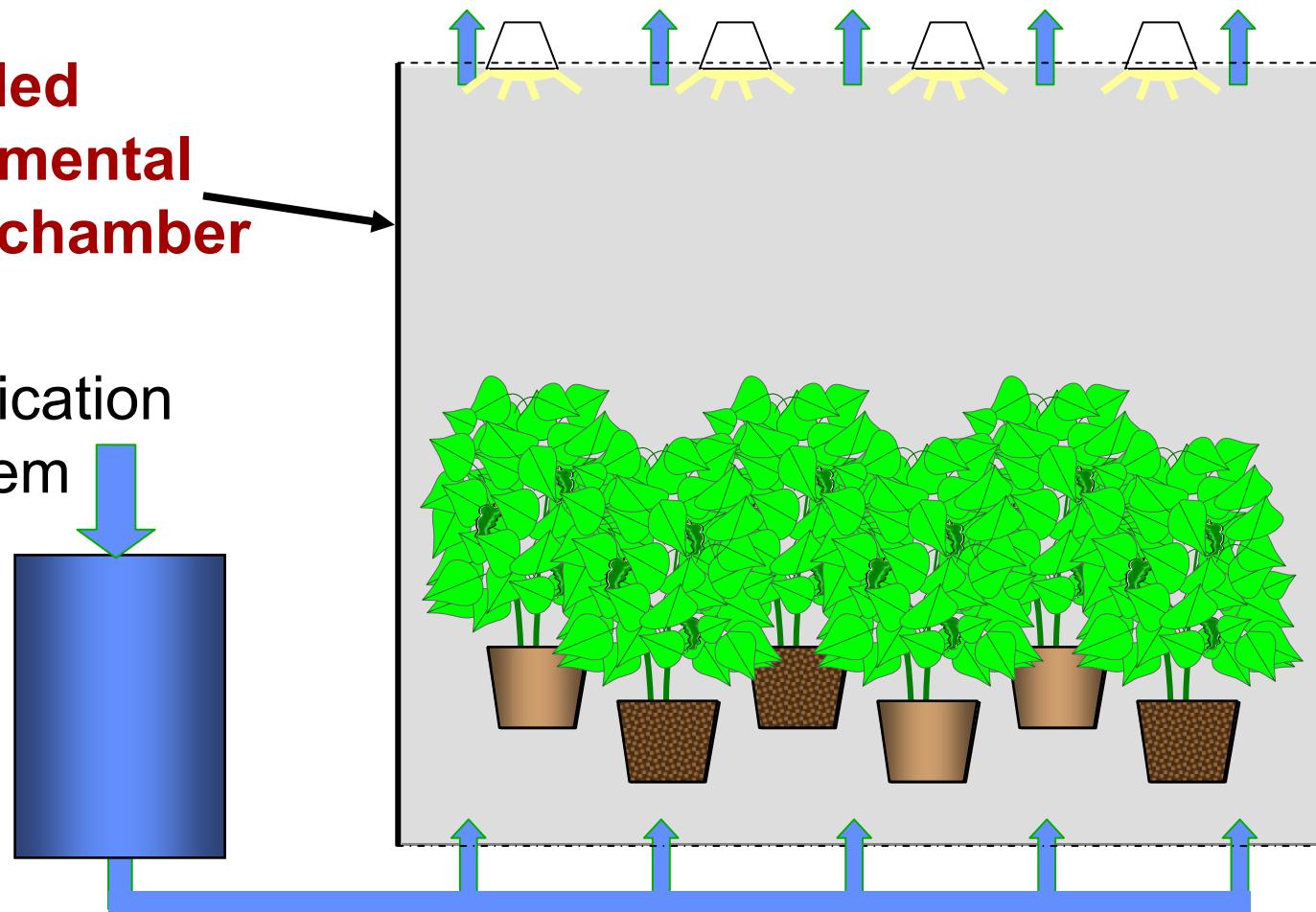
Relationship between minimum soil levels for measuring bioconcentration ratios and log K_{oa}



Measuring the pathway specific uptake of PAHs in aboveground vegetation

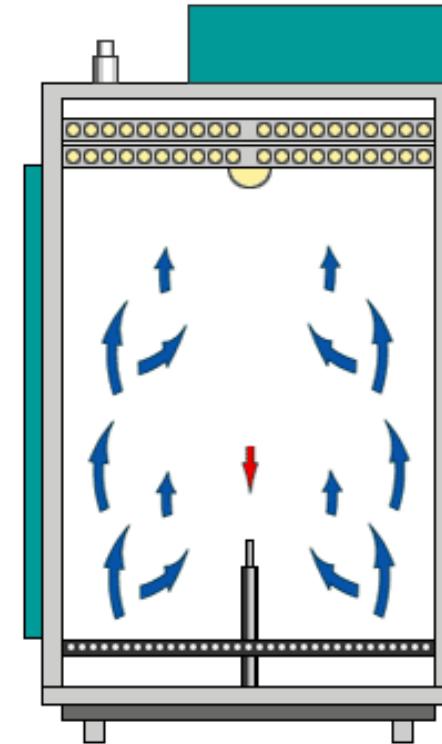
Controlled environmental growth chamber

Air purification system



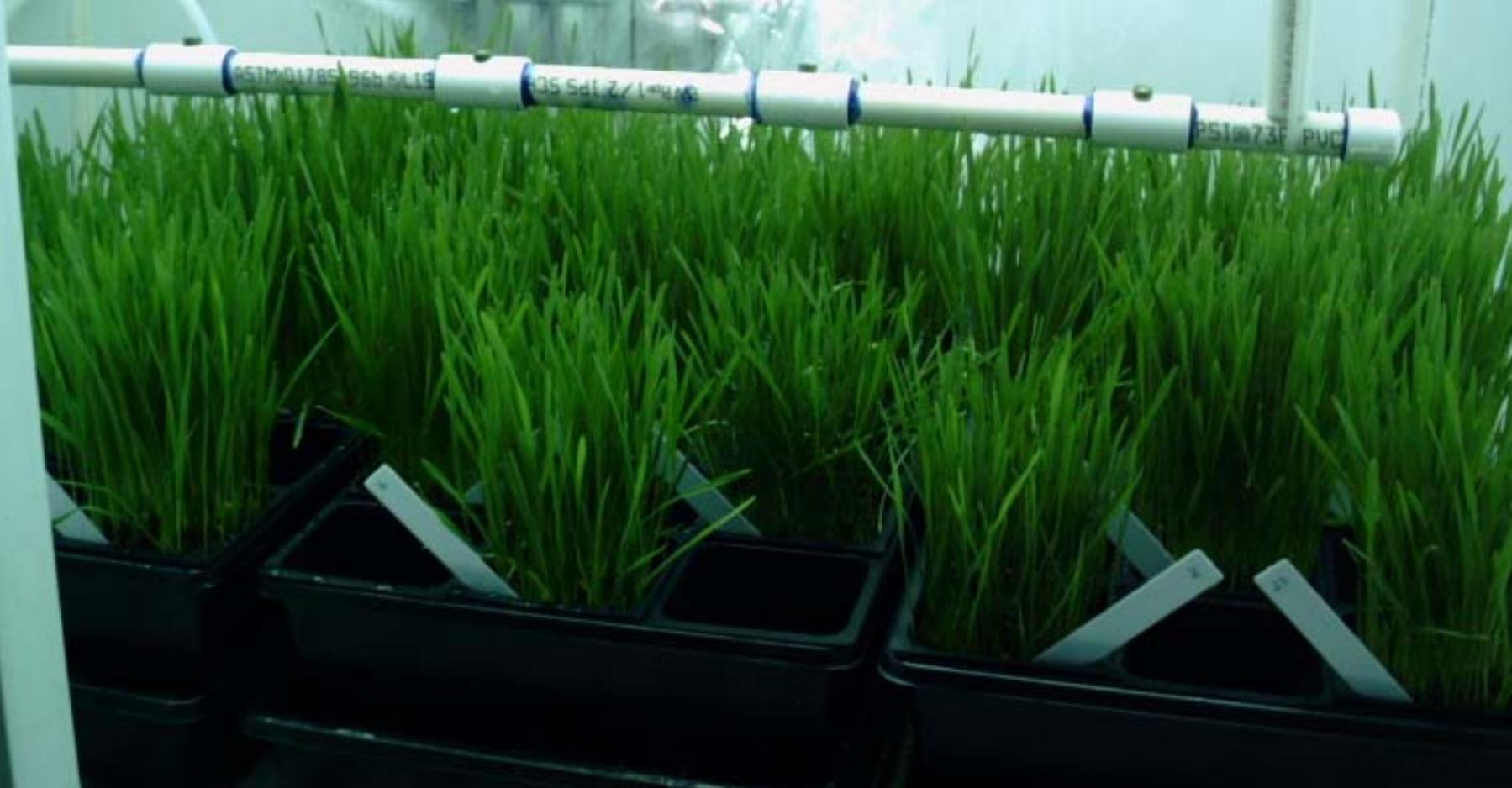
Experimental chamber

UC Davis Controlled Environment Facility



Automated System Controls

Humidity, light intensity, day/night cycling, nutrient irrigation, air exchange rate

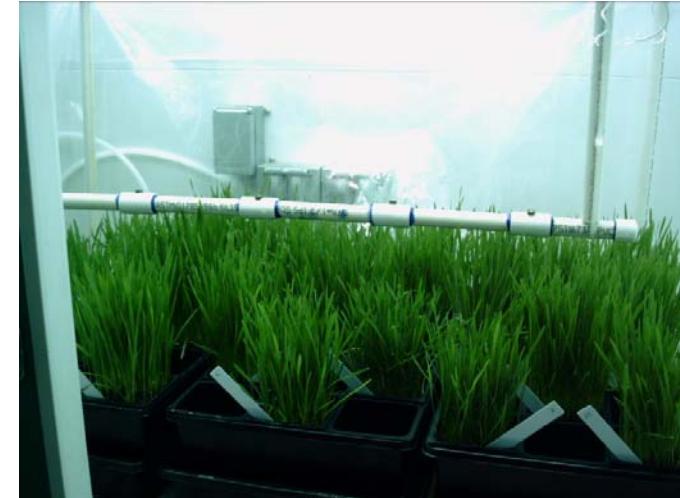
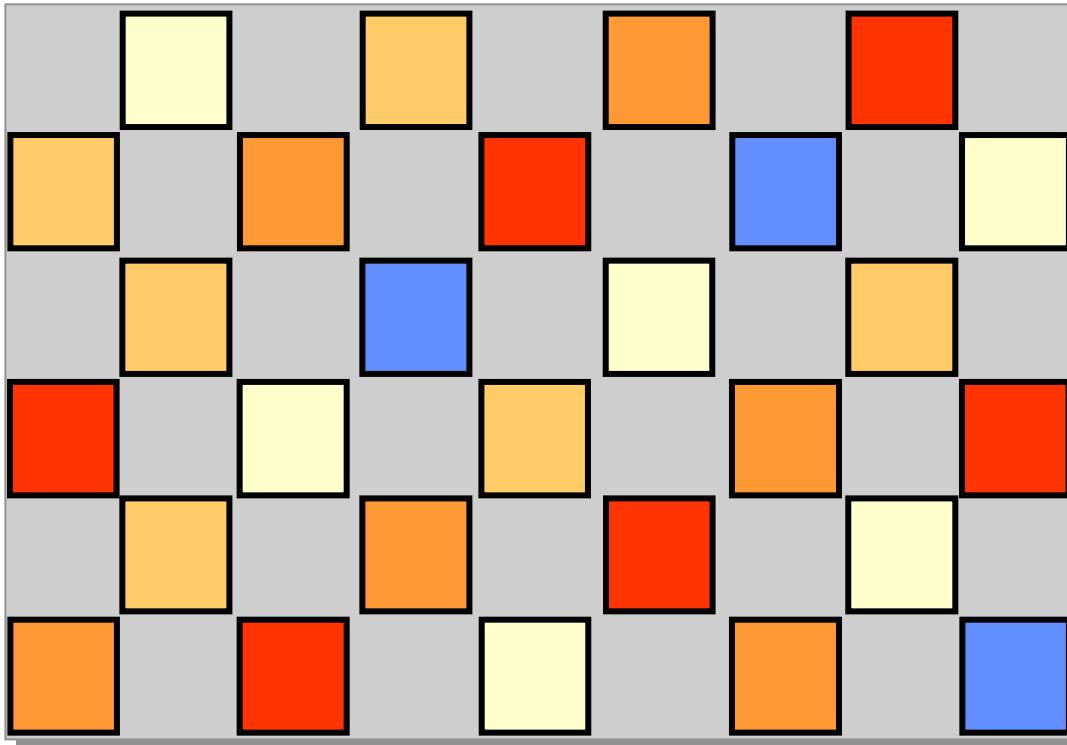


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Soil matrix (PAHs)



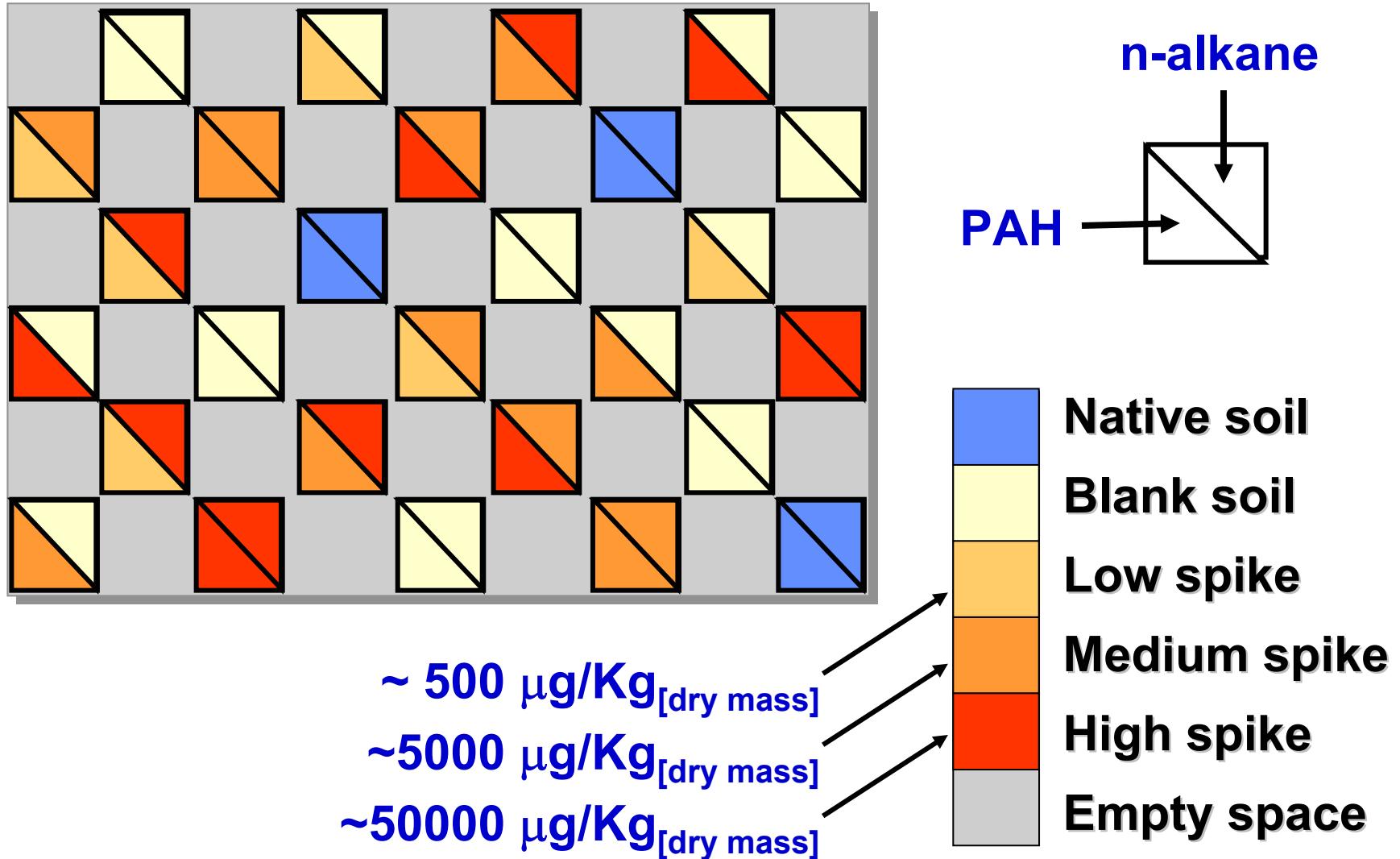
Native soil
Blank soil
Low spike
Medium spike
High spike
Empty space

$\sim 50 \text{ } \mu\text{g/Kg}$ [dry mass]

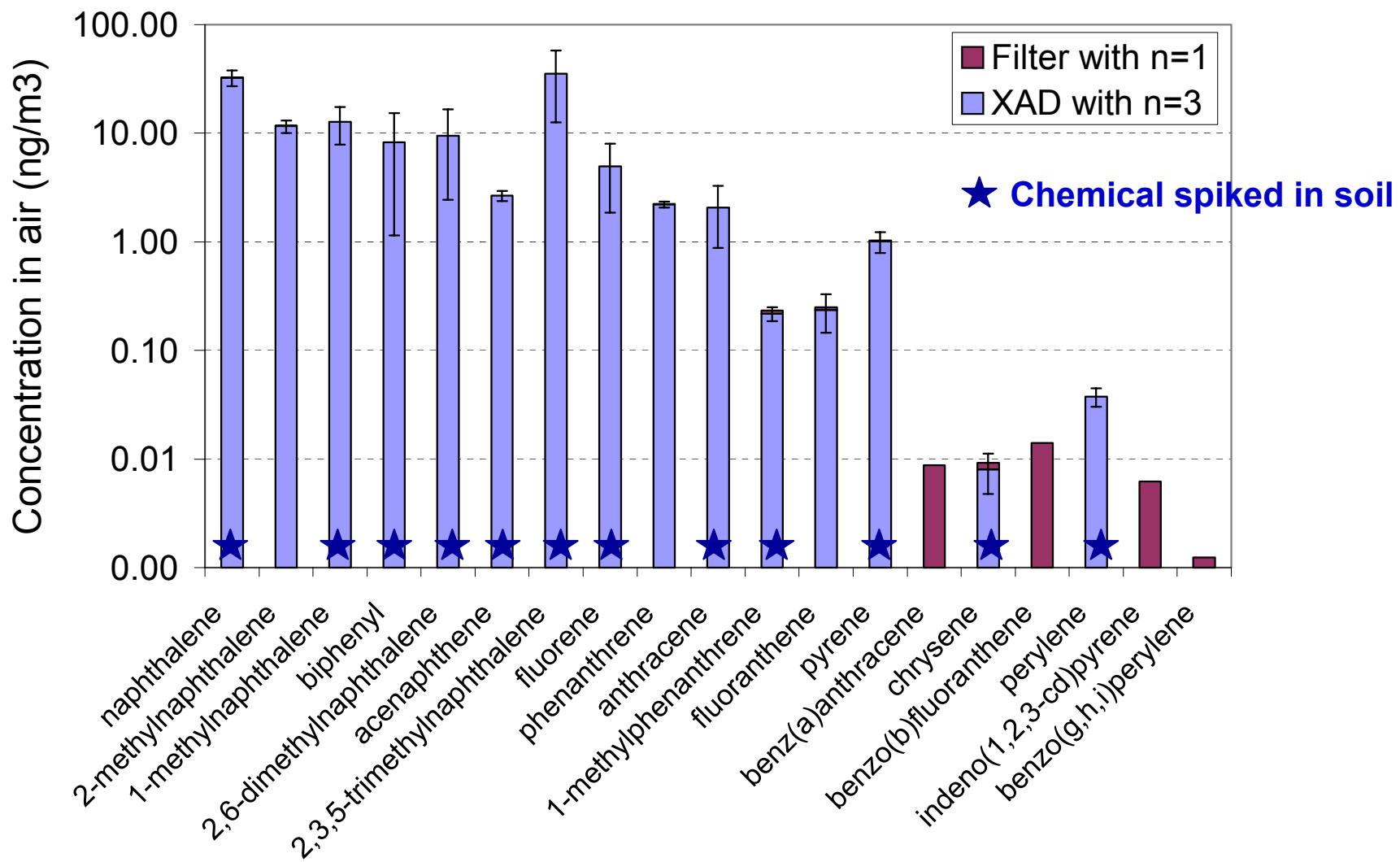
$\sim 500 \text{ } \mu\text{g/Kg}$ [dry mass]

$\sim 5000 \text{ } \mu\text{g/Kg}$ [dry mass]

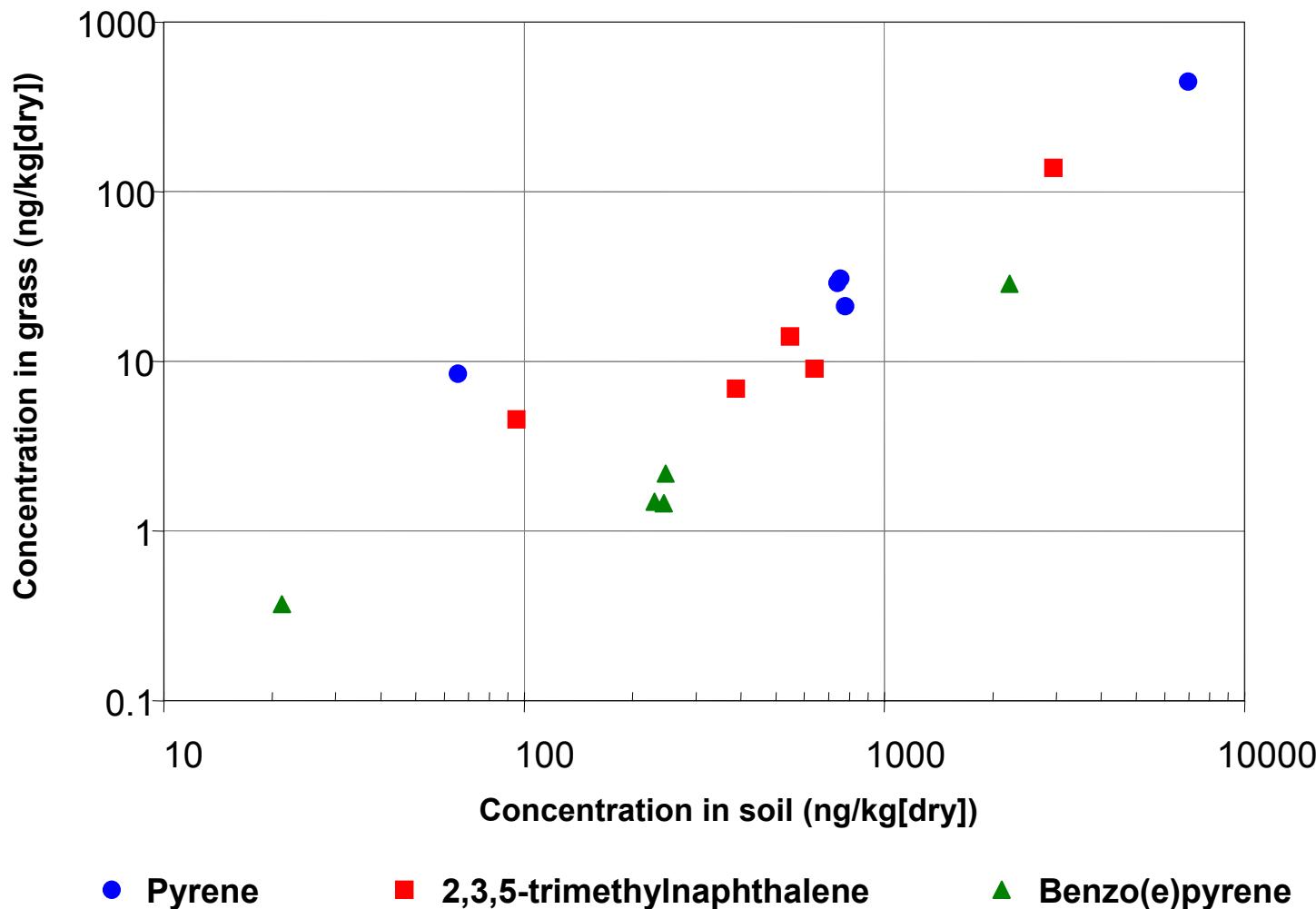
Soil Matrix (PAH + n-alkanes)



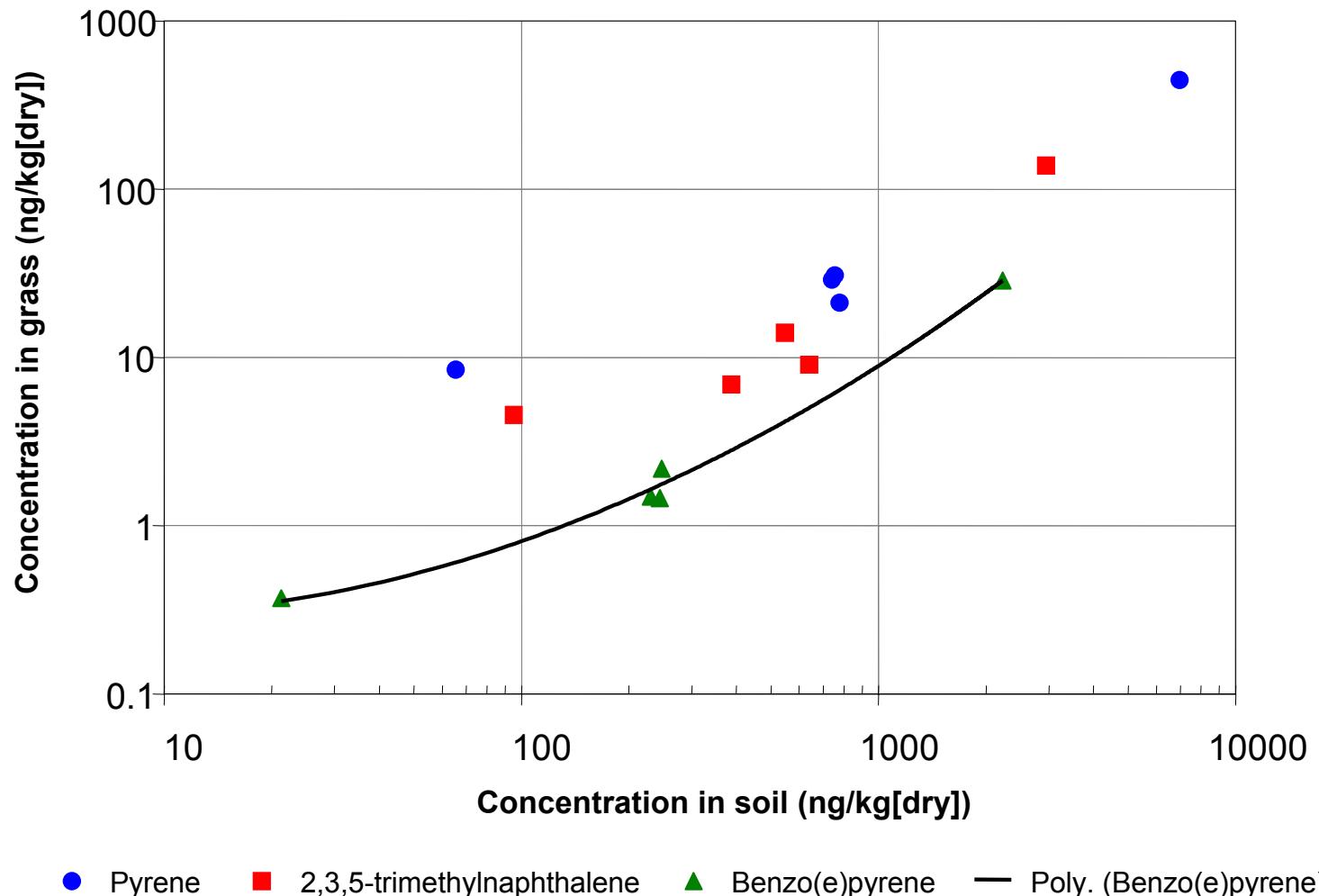
Air Concentration Results (PAHs)



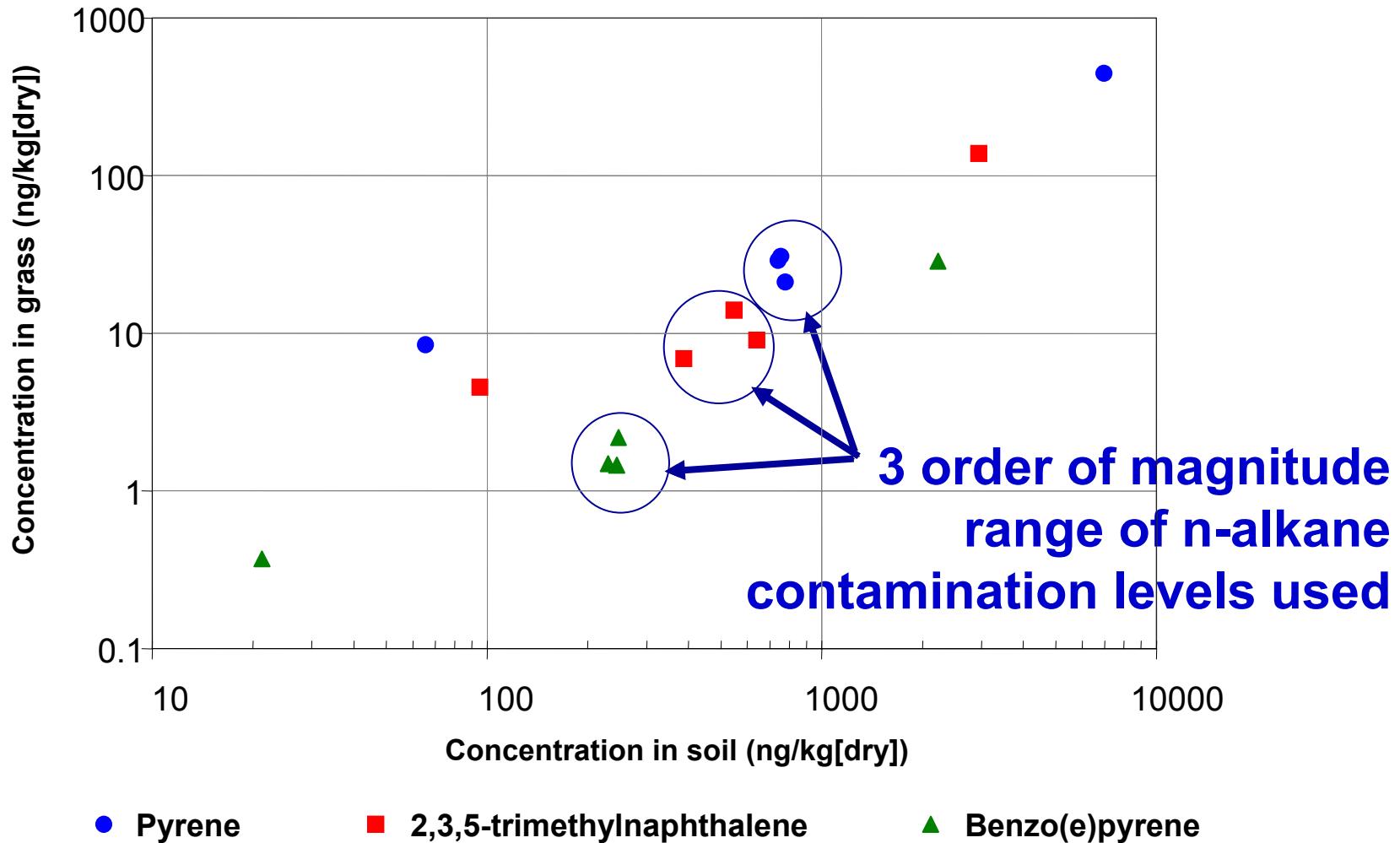
Grass/Soil Results (PAHs)



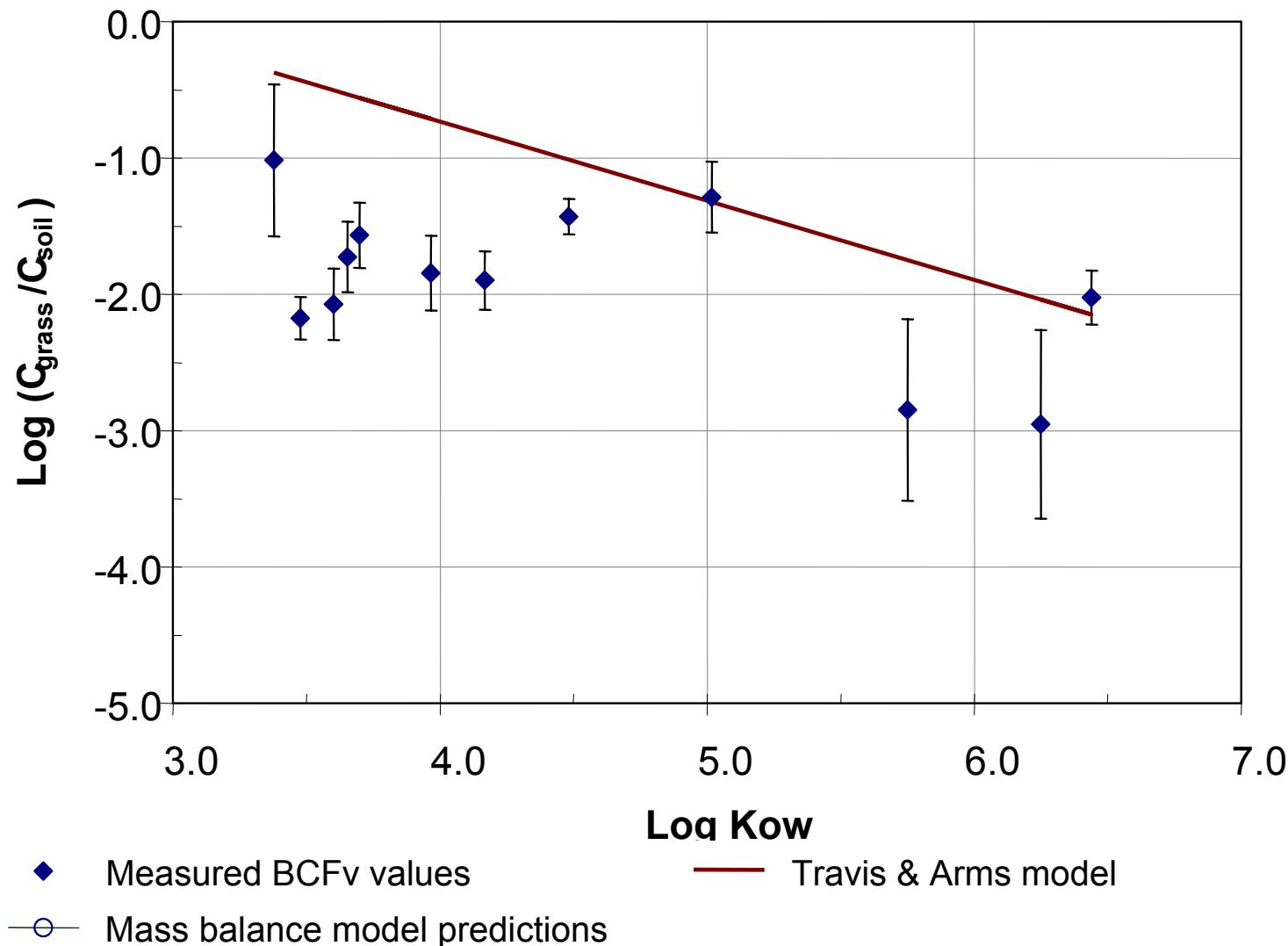
Grass/Soil Results (PAHs)



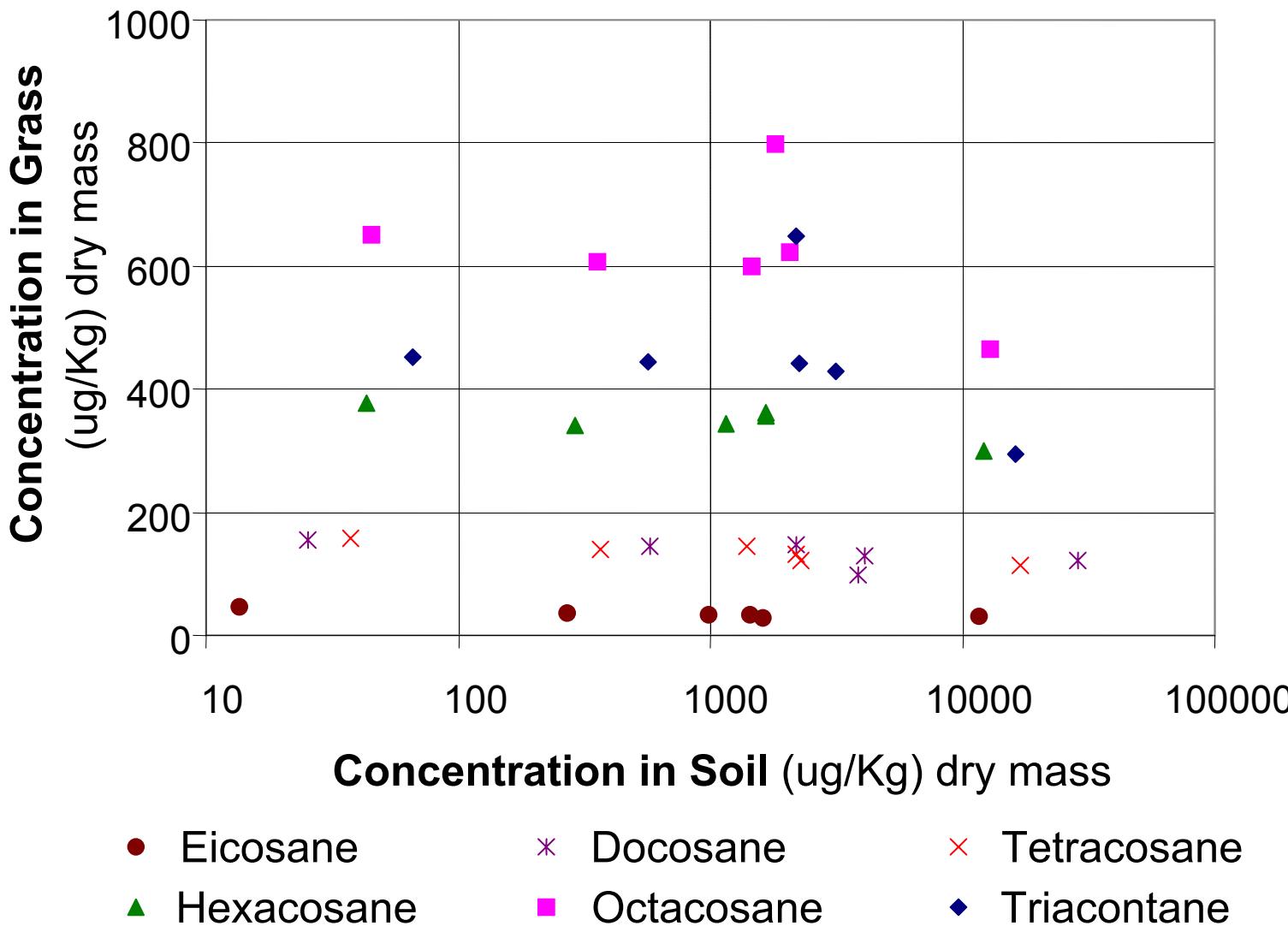
Influence of n-alkane contamination



Initial measured BCFs for PAHs



Initial measured BCFs for n-alkanes



Conclusions – R&D challenges

- Existing regression models are based on pesticides and persistent chemicals with little relevance to E&P sites
- Reported BCFs for PAHs are for low soil concentrations so air pathway dominates – not relevant for contaminated sites
- Measured and modeled BCFs for PAHs not linear on K_{ow} and lower than Travis and Arms model, particularly at high and low K_{ow}
- n-alkanes do not influence BCF for PAHs
- n-alkanes do not seem to accumulate in above-ground vegetation

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